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[North Carolina]

North Carolina. Geological survey. Reports of progress.

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REPORT

OF

THE PROGRESS

OF THE

GEOLOGICAL SURVEY

OF

NORTH-CAROLINA 1866.

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By PROFESSOR W. C. KERR.

RALEIGH;
WM. E. PELL, STATE PRINTER,
1867.

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OF

COMPARATIVE ZOÖLOGY,

AT HARVARD COLLEGE, CAMBRIDGE, MASS.

Founded by private subscription, in 1861.

Deposited by ALEX. AGASSIZ.

No. 40 [illegible]

Rec'd Mar 4/76.

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EXECUTIVE DEPARTMENT N. C.
RALEIGH, *January* 31, 1867.

To the Honorable,
The General Assembly of North Carolina:

GENTLEMEN:—I have the honor to transmit, herewith, the report of the State Geologist, and commend it to your careful consideration.

JONATHAN WORTH.

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REPORT OF THE PROGRESS

OF THE

GEOLOGICAL SURVEY OF NORTH CAROLINA.

To his Excellency, JONATHAN WORTH,
Governor of North Carolina:

SIR:—I have the honor to submit the following report of the progress of the geological survey of this State, since I have had charge of the work. I have prefixed a brief history of the survey itself, from its first inception, thinking it might be of some interest to yourself as well as the public.

My commission bears date April 4th, 1866. After completing the investigation of the subject of the Swamp Lands and the report thereon, which was undertaken at the request of your Excellency and the Literary Board, and, at the same time, acquainting myself with the history and condition of the geological survey, and having ascertained that there were no apparatus or instruments, either for field or labratory work, belonging to the survey, my predecessor having made use of his own and other laboratories north, I found it necessary, first of all, to provide an outfit, preparatory to taking the field. This brought me to the middle of summer. My work in connection with the actual survey, therefore, dates from this point.

An examination of the reports and official correspondence of my predecessor, having shown that the western portion of the State, beyond the Catawba River, was yet unsurveyed, your Excellency concurred with me in the opinion, that my attention should first be directed to that region. I accord-

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ingly crossed the Blue Ridge, and addressed myself to the task of making a rapid sketch of the transmontane section, hoping to complete the tour of those eleven counties within the remaining operative months of the year.

The weather having proved so auspicious as to permit outdoor operations until the beginning of December, I was able to carry out my plan beyond my own expectations, having travelled, mainly in the saddle, 1700 miles of mountain roads and mountains without roads, in less than four months. A summary of some of the more important observations is herewith respectfully submitted, with the hopethatyour Excellency will find something of the same satisfaction, with myself, in the discovery of the great and almost unknown resources, both agricultural and mineral, of the mountainous portion of our State. And it must be remembered that the region beyond the Blue Ridge, to which my explorations were limited, constitute only about one-half of the hitherto unexplored division of the State. The remainder, extending from the Blue Ridge and Yellow mountains, to the Catawba River and Pilot mountain, which will next claim attention, will, I am satified, from many general indications, prove equally interesting.

Your most obedient servant,

W. C. KERR,
State Geologist.

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PREFACE.

Before resuming the Geological Survey of the State, it was, of course, necessary for me to ascertain precisely the progress which had been made, and the point which had been reached by my predecessor; *i. e.* it was necessary to know what had been done in order to know what remained to be done. This investigation brought to my knowledge many facts in the history of the Survey, which seem to me to have an interest for others besides myself. A few of these will therefore be given in brief.

The first suggestion of a geological survey of the State, so far as appears from the records, was made by Prof. Olmsted, of the University, in 1821, in a letter to the Board of Public Improvements. Judge Murphy, however, on the part of the same Board, had, in their report for 1819, observed that, in executing the surveys which they were required by the Assembly to have made, in prosecuting their various schemes of internal improvement, they had "attempted to render the surveys subservient to the interests of science by collecting information of its geology and mineralogy," but had entirely failed. The letter of Prof. Olmsted was referred by the Board to the Legislature, but no action was taken. About this time, however, a new interest was given to the subject, by the discovery of the remarkable gold deposits of Cabarrus and the neighboring counties, which yielded the largest "nuggets" which had then been seen. When, therefore, the suggestion of Prof. Olmsted was renewed a year or two later, with the proposition to spend his vacations in geological excursions, and "asking merely such an appropriation as would defray the expenses of the undertaking," the result was the passage of an Act of Assembly in 1823, authorizing the Board of Agriculture to have such survey made, and appropriating for the purpose $250, for four successive years; which was afterwards continued for two years longer. The

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survey thus ordered was partly executed by Prof. Olmsted, and after his removal to Yale College, was continued by Dr. Mitchell. Their observations were published from time to time until 1827, occupying, in the aggregate, about 125 octavo pages. They were necessarily confined to the eastern and middle sections of the State.

Geology was then in its infancy, and in the light of the science of the present day, and in comparison with the huge folios of modern surveys, with their splendid illustrations, those thin and unpretending pamphlets look meagre and valueless, except, perhaps, to the antiquary. But they served an important purpose in their time, and contain, besides, a mass of information which is still valuable. Here the work rested until resumed under the present law on the subject.

Meanwhile the science of geology had grown from the smallest beginnings to an importance and breadth, wholly unimagined in 1825, and its practical bearings upon all the economies and industries of men, especially upon mining and agriculture, in discovering and developing the hidden resources of the earth, had become recognized and appreciated every where. The other States, as well as foreign nations, had, most of them, ordered and executed, many of them at an immense cost, complete surveys of their territory. The importance attached to such surveys elsewhere may be illustrated by a single example. The following is the law of California, whose survey is one of the most recently undertaken and is still in progress.

"AN ACT TO CREATE THE OFFICE OF STATE GEOLOGIST, AND TO DEFINE THE DUTIES THEREOF.

The people of the State of California, represented in Senate and Assembly, do enact as follows:

SECTION 1. J. D. Whitney is hereby appointed State Geologist. He shall be commissioned by the Governor, and it shall be his duty, with the aid of such assistants as he may appoint, to complete the geological survey of the State, and prepare a report of such survey for publication, and superintend the publication of the same. Such report shall be in

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the form of a geological, botanical, and zoological history of the State, and the number of copies of each volume to be printed, and the style, form, maps, diagrams, or illustrations to be contained therein, or to be published separately, shall be determined by the State Geologist; and said report, when published, shall be sold upon such terms as the Governor and Secretary of State shall decide upon, and the proceeds of such sales shall be paid into the Common School Fund of the State.

SEC. 2. It is hereby made the duty of the State Geologist, and his Assistants, to devote the time not necessarily required, in the preparation and superintendence for publication of the reports provided for in section one, of this act, to a thorough and scientific examination of the gold, silver and copper producing districts of this State, and to make such scientific and practical experiments as will be of value in the discovery of mines and the working and reduction of ores.

SEC. 3. The following sums of money are hereby appropriated, out of any money in the State Treasury not otherwise appropriated, for the prosecution of the Geologist Survey of the State, and for the sixteenth and seventeenth fiscal years: For salary of the State Geologist, nine thousand dollars, to be drawn monthly, on the last day of each month; for the salary of two Assistants, six thousand six hundred dollars, to be drawn in the same manner as the salary of the State Geologist; for publication of two volumes of reports, six thousand dollars; for office rent, and expenses of survey in mining districts, and experiments on ores, and all incidental expenses of work, ten thousand dollars, to be drawn one-half each fiscal year.

SEC. 4. This act shall take effect immediately.

Approved, April 4, 1864.

F. F. LOW, Governor."

The State of North Carolina had long been pointed out by scientific travellers, as well as by the labors of Prof. Olmsted and Dr. Mitchell, and by accidental discoveries, as the repository of great and varied mineral wealth; and the necessity of an adequate and complete survey was widely felt and its

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authorization was frequently and earnestly advocated by the leading men of the State, and often formed the subject of Executive messages and of legitimate discussions. I quote from three annual messages.

"A Typographical, Geological and Minerological Survey of the State is highly desirable. The minerals and ores are believed to be incalculably valuable; and the limestone and marble which might thus be brought to light, would benefit the farming interest beyond the cost of the undertaking." (Gov. Dudley, 1838.)

"I believe the same amount of money could not be so usefully applied in any other way, as in procuring these surveys." (Gov. Morehead, 1844.)

"I trust no consideration will induce a longer delay in directing an Agricultural, Geological and Minerological Survey of the State. Three-fourths of our sister States have now in progress, or have finished like examinations of their territories. And in every instance, it is believed, that they have not only added to the treasures of science, but have been attended with important and useful discoveries. Many valuable minerals are already known to exist in various sections of the State; and a further exploration cannot fail to bring to light other resources, and greatly favor the pursuits of Mining and Manufacturing; while a minute examination of our soils by persons uniting science and practical skill in agriculture, will be productive of improvement in that useful branch of industry." (Gov. Graham, 1846.)

At the session of 1851–'2, the existing law on the subject was enacted; which is found on page 69, chap. 2, of the Rev. Code. As this constitutes the authority under which the present Survey proceeds, and is familiar to very few, it is inserted here.

"SECTION 13. The Governor shall appoint a suitable person to conduct, under the supervision of himself and the Literary Board, a Geological, Mineralogical, Botanical and Agricul tural Survey of the State.

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14. The person appointed shall examine and survey each and every county of the State, and ascertain the different geological formation of each county and section of the State; the nature, character and value of its minerals; the nature and character of its soils, and the best mode of improving the same; the nature and kind of its productions, and their relative position and value; its facilities for manufactories; the extent and value of its water-power; the character and value of its botanical productions; the character and value of its timber, and all other facts connected with the subjects of Geology, Mineralogy, Botany and Agriculture, which may tend to a full development of the resources of the State; and such person is authorized to employ as many proper agents and assistants, to be approved by the Governor, as may be necessary to enable him speedily and successfully to accomplish the objects committed to his charge; and he shall, from time to time, communicate to the Governor, to be by him communicated to the Legislature, a report, or reports in writing, setting forth fully the results of his Survey; which reports shall be published under the supervision of the Governor and Board of Literature.

15. The expenditures incurred by said Survey shall not exceed five thousand dollars per annum, to be paid by the Public Treasurer, upon the warrant of the Governor, out of any monies in the Treasury, not otherwise appropriated.

16. The person making such survey, shall deliver lectures upon the subjects committed to his charge, in the villages through which he may pass: Provided, that he shall not thereby delay his other duties."

Dr. E. Emmons received the appointment of State Geologist under this act, in 1852, and retained the office until his death, in 1863. His son, Dr. E. Emmons, Junior, was nominated assistant Geologist. Dr. E. has given the results of his labors in five reports.

The first, issued in the latter part of 1852, relates to the Agriculture of the lower counties, and the coal of Rockingham and Chatham.

The second report, in 1856, is the largest of the series, and relates chiefly to the Geology, and particularly to the mines of

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the "midland counties," and has some additional matter on the coalfields.

The report for 1858, is a general treatise on Agriculture. Two short reports appeared in 1860; one, a continuation of the report on Agriculture, the other on the Swamp Lands.

During this last year was also issued a report by Dr. Curtis, on the "Woody Plants of North Carolina," prepared at the request of Dr. Emmons. His Catalogue of the plants of the State was presented for publication at the same time, but for some unexplained reason, failed to get through the press. This catalogue, together with two other reports by the same distinguished gentleman, one on the "Mammals," the other on the "Reptiles of North Carolina," still await publication, having been prepared in connection with the survey.

It appears also, from a letter, or brief report of Dr. E. to Governor Ellis, in 1860, that there was still a considerable amount of material on hand for publication; including many analyses of soils and minerals, with additional discoveries in the coal region; also a report by Mr. C. D. Smith, of Macon county, on a portion of the mountain section of the State, with some observations by himself in the same section; and he has also alluded, several times, in his published reports, to a Geological Map of the State, as in course of preparation by the draughtsman of the survey, Dr. E. Emmons, Jr.

No work seems to have been done in connection with the survey after 1860, Dr. Emmons' attention having been turned to the manufacture of warlike munitions. And there is no *report* of any geological operations subsequent to that of 1856.

Having been myself appointed State Geologist in 1864, and having held the office during the last year of the war, *nominally, and without pay, and with special instructions* to look after certain chemical and mineral manufactures, in which the people of the State were vitally interested, and becoming acquainted with the above stated facts in reference to the condition of the Survey, it appeared to be my duty to collect such papers and documents connected with the work, as might be of value to the State, especially to secure the map which was a most important desideratum, and might be ex-

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pected to constitute a most valuable summary of the complete results of the survey. Supposing these papers to be in the custody of the surviving family of Dr. E., and especially of his assistant, I accordingly made application for them under the executive sanction and authority. And the application has been several times renewed, since the close of the war, and with the approval of his Excellency, the present Governor, but so far without success.

The geological survey, then, has been in progress about nine years, from 1852 to 1860. The reports published relate to the Geology and Agriculture of the eastern section of the State, including the Swamp Lands, and to the geology and mines of the "midland counties," as far west as the Catawba River. The portion of the State beyond this to the Tennessee line is, so far as appears from the reports, wholly unexplored.

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CHAPTER I.

INTRODUCTORY.

In undertaking a Geological Survey, two things require to be definitely settled,—*the object* and *the method.* Some observations on each of these points will probably not be deemed out of place here:

THE OBJECT

Or design of the Geological Survey of North Carolina, is to be gathered chiefly from the law establishing it. From this it appears that a General Geological Survey is contemplated. Such general survey has necessarily a two-fold purpose and aspect, scientific and practical. The first is in order to the second, as a means to an end. But it is also an end in itself, in the same sense and degree, and for the same reason that all true science is so. And then we have long enough seen, on the geological maps of the ocntinent and of the world, that appear from time to time, the space of North Carolina occupied by broad analogical conjectures, or left wholly blank, like the centre of Africa, or the Antarctic continent. The scientific, however, owes its chief value to its relation to the practical in the legislative intention. For it is only by means of a systematic and thoroughly scientific investigation of the geological structure and characteristics of a region, that results of any value in themselves can be reached, or that will carry with them any credit or authority abroad. It is only when geological observations and deductions are thus characterized, that they can be brought into comparison with similar results in other parts of the world, and foreigners be enabled to assure themselves of the probability and value of alleged discoveries.

The immediate practical bearings of the survey are prominently considered as looking in two principal directions, the developement of the mineral wealth that may be concealed

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beneath the surface, and the promotion of agriculture. It would certainly be difficult to over-estimate the importance of any agency which may reasonably be expected to advance these two leading interests of mankind. It is little that we do not owe directly or indirectly to the soil, or the mine.—Almost no art or industry is independent of these two great sources of individual and national prosperity. Where are we to look here in North Carolina, in our depression and calamity, for the recuperation of our lost fortunes and the restoration of our prostrate business, if not to the improvement of our soil and methods of tillage, and to the mineral riches hidden away in their subterranean storehouses? In establisking the Geological Survey with a view to the promotion of these so important interests, the Assembly of North Carolina have but adopted the experience and endorsed the judgment of the most practical and enlightened and prosperous states of Europe and America. It is impossible to estimate what the Geological Surveys of England, of France, of Pennsylvania, have done for their mines of coal, salt, iron, or to realize their effect upon the prosperity of those States.

The connection of Geology with mineralogy and mining is immediate and obvious, so much so that it is popularly regarded as simply the science of ore-hunting. It serves, in the first place, to direct and to limit the operations of the miner, and tells him where his labor may be profitably expended. By determining the age and relations of the rocks of a region, it indicates the limits within which certain minerals may be found; and traces the connections and outlines, the direction and position, the *strike* and *dip* of beds and veins of minerals, and thus points out the proper plan of mining operations to be adopted in each case. Hence the intelligent capitalist hesitates to invest in mineral property without consulting competent geological authority; and the intelligent immigrant, to venture into a new country, without first consulting its geological reports. It is this which has lately given so high a market value, even to the partial and incomplete reports of this and some other of the southern States, and created so great a demand for them north and in Europe, that scarcely a copy can now be found. The nega-

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tive effects and value of geological surveys are scarcely less important than the positive. The miner is not only directed where he may bestow his labor profitably, but is likewise deterred from operating in other directions, where his labor would be fruitless and ruinous. Millions have been squandered even in our own country in the useless and foolish search after minerals which never existed. "In the upper valley of the Delaware and Schuylkill, and in many other places, men have spent years, long lives in fact, and fortunes, in digging vainly into the black slate for coal." (Lesley.) And the question is often asked here, whether coal may not be found, and search has often been made for it, in certain localities in the western portion of our State, where its presence would give immense importance and value to the vast accumulations of iron ore, which characterize many of those counties. Geology at once pronounces the search futile. And so, just now, the question is frequently asked, whether petroleum may not be found in different parts of the State; and large tracts of our mountain lands have been lately bonded by parties prospecting for oil. The geologist has no difficulty in pronouncing all such projects utterly hopeless, as to the whole of that region, and in indicating these very limited tracts within our borders, where alone such operations have any possibility of success. And so of iron works which have often been projected on an extensive scale, upon the mistaken suppositio of the presence of the proper quantity and quality of ore. I have frequent occasion to forestall and prevent useless expenditures and hopeless enterprises of this sort. And the least geological information, the rudest geological survey of our western counties, would have prevented the enormous waste of time, energy and money that have been expended by hundreds of men, for many years, in the ridiculous pursuit of a mineralogical phantom, in the search after repetitions and continuations of *Ducktown*.

But the relations of the survey to agriculture, which must ever remain the chief employment and resource of our people, are equally real and important, although not equally obvious. The Act of Assembly under which the survey proceeds, requires that special attention be given to this subject, and

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specifies the analysis of soils, and directs attention to whatever may contribute to the promotion of this interest. Soil is derived from and owes its composition and character to the subjacent rock. Every one has observed, in travelling from east to west in this State, the frequent and complete transition from one color and physical character of soil to another. And it can hardly have escaped even the casual observer that such change is always coincident with a change in the underlying rocks, indicating unmistakably a genetic relation. Thus granite gives rise, by its disintegration, to a certain description of soil, whose essential ingredients are precisely limited and determined by the composition of that rock; and so of clayslate, sandstone, trap, &c. Of course alluvial and drift soils are exceptional, their material having been transported and sorted after disintegration. So that Geology, calling in the aid of Chemistry, points out the origin, composition and differences of soils, and suggests the mode of their preservation, restoration and improvement, and indicates also the source whence their deficiencies may be supplied.

But the tiller of the soil has yet other difficulties to contend with and other doubts to be resolved. The same soil in different latitudes and at different elevations above, and distances from the sea, will not yield the same crops. Moisture, limits of temperature and its annual average and total amount, and all those complex and varied climatic conditions which affect and control the growth, and determine the range of plants, as the grasses, grains and fruits, which again limit and determine the employments and pursuits of populations,—all these demand investigation, and are properly committed to the survey. The Act of Assembly also directs observations to be made on the Botany and Zoology of the State, both because these are necessary to the completeness of the survey, and are demanded by science, and (chiefly) because, without them, no description of the capabilities, resources and natural adaptations of a country can be accounted full and satisfactory; and hence these things are always prominently set down by travellers and explorers of new countries.

Lastly, a *collection* is required to be made, which shall ex-

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hibit, in a general view, the soils, minerals, botany and zoology, which shall, in fact constitute an epitome of the geological and natural history, the agricultural and mineral characteristics and resources of the whole State. So much in brief for the objects proposed to be accomplished by the Geological Survey.

THE PLAN OF OPERATIONS.

Since the general geological survey must necessarily serve as the basis and ground-work of the whole, this comes first in order. It was necessary, therefore, in the beginning, to take a bird's-eye view of the whole field of operations,—to make a geological reconnoissance, in order to catch the outlines and leading features of the geological structure of the region to be studied, and thus to construct a skeleton, or framework in which all the future details of the work would easily and intelligibly arrange themselves, as they should be developed. This was necessary also, in order to ascertain the character and amount of the work to be done, and to what points special effort and attention should be directed. This could be accomplished most speedily and satisfactorily, by making a series of transverse sections across the upturned edges of the strata. In this State, the direction of these edges, the *strike*, is almost universally from N. E. to S. W. And this direction, being also that of the dominant mountain chain, the rivers, in seeking the line of quickest descent, necessarily take a direction at right angles to the strike; and having worn for themselves deep channels through the strata, furnish extensive exposures of the rocks, and so give the readiest means of obtaining the desired sections; although one is often obliged to use, for this purpose, the artificial and accidental exposures along the tracks of railroads, turnpikes and even common roads.

The Ocoee, Hiwassee, Cheowah, Nantehaleh, Tennessee, Tuckasege, Pigeon and French Broad, with the Ocoualuftee, and Toxaway, furnished me as many sections, some of them partial, some of them completely across the breadth of the State. These sections enabled me to locate, beyond the possibility of a doubt, all the prominent geological features of

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the region, and furnish data also for the construction of a geological map of that hitherto unknown country. I was thus able also to set at rest the great question, so much discussed among the numerous indigenous and exotic geologists, miners and speculators of that section, as to the course and position in North Carolina of the "Ducktown Lead." It is universally believed and taken for granted that the rocks which contain those remarkable accumulations of copper ores on the Ocoee at Ducktown, pass eastward, through the whole mountain section of this State, and contain all the copper of Macon and Jackson, to Ashe county. This opinion is shared by the most intelligent citizens. The above sections, however, demonstrate that the copper slates of the Ocoee are not found this side of the Smoky Mountains, and that the copper "veins" of Jackson, &c., belong to an entirely different geological age and formation, being in fact far more ancient and *possibly* having furnished the material for those later segregations of Ducktown.

PALEONTOLOGY.

In this department much remains to be done. Neither the Tertiary fossils of the eastern counties, nor the Mesozoic of the Deep River and Dan River Coal beds, nor yet the supposed Azoic (so-called Taconic) organisms of the middle section have been fully and satisfactorily studied and illustrated. I am gratified to announce, however, that so much interest is felt by scientific men in these subjects that several of the most eminent paleontologists of the country have proffered their services gratuitously to work up whatever material of this sort the progress of the survey may bring to light. This fact is the more worthy of mention, because this is usually the most tedious and expensive part of the whole work.

GEOGRAPHY, PHYSICAL GEOGRAPHY AND TOPOGRAPHY.

In the prosecution of the Survey, one of the first difficulties encountered arose from the want of an accurate geographical

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map, on which to locate my geological observations. There is no map of this region in circulation ; worthy of thename, those which we have being nothing but the rudest conjectures. I had hoped to find, in the archives of the capitol, sufficient material for the construction of a skeleton map, on which to lay down my observations. During the period from 1821 to 1843, while the Board of Internal Improvement had in its employ a State Engineer, surveys were made of all our rivers on this side of the Blue Ridge, and of many small creeks also, from the seacoast to the base of the mountains; and during that period and up to the present time, numerous surveys have been made (mostly at the public expense) of routes for rail roads, turnpikes, canals and common roads, making an aggregate of several thousand miles. The field-notes, plans and drawings of these, if they had been preserved, would furnish a net-work of lines covering the whole State, and would leave little to be done in order to construct an accurate geographical and even an approximate topographical chart. But not half a dozen of these surveys have left any available trace of their existence among the records. The difficulty, however, was partly overcome by means of a hand-copy of a map (kindly furnished me by the author, for this purpose) of the mountain section of the State. This map is in course of preparation for publication by Prof. A. Guyot, of Princeton, the first of living geographers, who has done more for the elucidation of the geography and topography of our mountains than all other observers together. Having provided myself with barometers and sextant for the purpose, I have made many additional observations for the determination of altitudes and the triangulation of those sections omitted by Prof. Guyot. I have the satistaction also of announcing that this gentleman has promised me his co-operation for three or four weeks, in the spring, in order to complete this important work, of which he will shortly give us the entire results.

Inasmuch as the absolute geographical position of no point west of the Blue Ridge (and so far as I know, west of the University,) had been determined by astronomical observations, having provided, in my outfit, a chronometer and marine sextant, I made, in passing through the several county

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towns, a series of double-altitude observations, for the purpose of fixing the latitude and longitude of those points, which will give a degree of accuracy otherwise unattainable, to all the geodetic observations which have been, or may hereafter be made, in that section, and will render them available as a basis for the geological survey and map.

In making the barometrical observations, Mr. Charles Curtis, of Hillsboro', volunteer assistant, rendered me essential service as corresponding observer.

CLIMATOLOGY.

The survey is also indebted to volunteer assistance in this department. I have established, through such aid, a series of meteorological observations in each of the counties visited, the observers being furnished with instruments of simple construction for the purpose. These observations will continue as long as the survey lasts, and will furnish the means of ascertaing the annual fall of rain, its distribution through the seasons, the temperature, and the other elements of climate of the several mountain plateaus. I propose to extend this system of observations over the whole of our mountain counties, the climate and products of which vary much, even within short distances.

CHEMISTRY.

As I found no laboratory attached to the survey, and as the annual appropriation is entirely inadequate to purchase the necessary apparatus, I have availed myself of the courtesy of the President and Chemical Professor of the University, who have offered the use of the College laboratory. I have also made arrangements with an eminent chemist at Charleston, S. C., Prof. N. A. Pratt, who will make such analysis of soils and minerals, as may be required by the Survey from time to time.

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BOTANY.

This department has been so thoroughly worked up by Dr. Curtis, and other scientific explorers that almost nothing remains to be added.

ZOOLOGY.

Here also little will be required of the survey, since the elaborate and extensive works on the general subject of American Zoology, published under the auspices of the Smithsonian Institution, and the monographs of Dr. Curtis already referred to, have covered almost the entire ground. Whatever new material may come to light, however, during the course of the survey, will be placed in the hands of Dr. C. and those other distinguished naturalists to whose department the specimens may belong, who, in their devotion to science, have offered their aid for this purpose gratuitously.

CABINET.

Of the collection of minerals and fossils which had been placed in the Geological room of the Capitol by Dr. Emmons, the very small remnant, which escaped the ravages of the soldiers which occupied the city after the close of the war, was removed, under an act of Assembly, to the University. A cabinet is justly considered as among the most important and valuable results of a geological survey. A judiciously selected and properly arranged collection would exhibit, in one view, the whole geology of the State, and should furnish palpably the "testimony of the rocks" themselves to the truth of the observations and deductions of the written reports. Such a collection would reveal to the man of science the general geological structure of the State, and even many of the details of the lithology, position and succession of the formations, as well as their fossil contents; and should also represent its botanical and zoological productions. But, in addition to this, it should convey instruction of a practical character to the intelligent miner and farmer. To the latter, by a judicious selection and arrangement of the principal different

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kinds of rocks, with their derivative soils, and, with analyses of each, it would furnish the means of identifying his own particular soil, of referring it to its proper class, and so of discovering its character and defects, and the proper remedies: while the former, by a proper collection of ores and their associate minerals, their gangues, wallings and enveloping rocks, would be enabled to form a correct judgment of the value and character of the different mineral veins and districts of the State, without the labor and expense of visiting them.

MAPS.

These are valuable, and indeed essential, for the same reasons, viz., that they serve to condense and reveal, in a single, intelligible and connected view, the aggregate results of the whole survey, showing, at a glance, the kinds of rocks which occupy the entire surface, in their due position, order and succession and relative extent.

All these different departments of the work go on simultaneously, without interfering with each other; so that the whole series of observations are completed for a given district in a single tour.

I have been thus explicit in the exposition of the plan of procedure, which appeared to me to be best adapted to accomplish most successfully, the design of the survey, because I believed that so much would be both intelligible and interesting to a large class of our people, and because such a course seemed likely to increase the public interest in the work, which, it is every way desirable and important to do, and because I have no sympathy with that spirit in which science is sometimes seen to envelop itself with an air of oracular reticence and remoteness, and to write over the doors of its chambers, the mandate of exclusion and mystery, *Procul, O! procul este, profani.*

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CHAPTER II.

OUTLINE OF THE GEOLOGY OF WESTERN NORTH CAROLINA.

I wish this to be considered as a *report of progress*, and not as a final or complete *geological report* of the section to which it relates; the work done being, as already explained, only a reconoissance preparatory to a detailed survey. The entire results of even this preliminary examination can not be given in this brief sketch. This could only be done after making all the computations for the Barometrical and Astronomical observations, and constructing maps and sections from numerous field notes, and making analyses of a large number of the specimens collected.

The territory explored, comprising the eleven counties west of the Blue Ridge and Yellow Mts., and extending from Mitchell to Cherokee, contains an area of some 4000 square miles. The following brief description of the physical features of the region by Prof. Guyot, is of sufficient interest in this connection to justify its insertion here. It is taken from an elaborate paper "On the Apalachian System," published in the American Journal of Science, in 1861:

"The vast belt of the Appalachian highlands forms the marginal barrier of the American continent on the Atlantic side, and determines the general direction of the coast line, which, in general, runs parallel to the inflections of its chains with remarkable regularity. This system, composed of a series of corrugations tolerably uniform, does not, like the Alps, or other great systems of fracture, have a central or main axis, to which the secondary chains are subordinated. But it is properly compared, to the system Jura, for it is composed like that of a series of long folds, or chains, which run parallel to each other, often with great regularity. In the same part of the system the general height of the chains is sensibly equal and their summits show neither many nor deep notches. In the middle regions, especially in Pennsylvania and New Jersey, they present the appearance of long and continuous walls, the blue summits of which trace along the horizon a uniform line seldom varied by any peaks or

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crags. In the extreme northern and southern portions, however, this character is considerably modified. There the system loses very much of its uniformity and its physical structure becomes far more complicated; the form of simple parallel ridges almost entirely disappears.

There is one feature of the Appalachian system which distinguishes it from the ranges of the Jura; it is the well marked division into two longitudinal zones of elevation, one turned towards the shores of the Atlantic, in which the form of parallel chains just spoken of predominates, and the other turned towards the interior, which is composed of elevated and continuous plateaus, descending from the summit of their eastern escarpment, in the centre of the system, in gentle stages towards the basins of the lakes and the valley of the Ohio. Another feature, not less conspicuous, characterizes the region of corrugations properly so-called. This is a large central valley which passes through the entire system from north to south, forming, as it were, a negative axis through its entire length. This is what Mr. Rogers calls the great Appalachian valley. At the north it is occupied by lake Champlain and the Hudson river; in Pennsylania it bears the name of Kittatiny or Cumberland valley. In Virginia it is the Great valley; more to the south it is called the valley of East Tennessee. At the northeast and at the centre, its average breadth is fifteen miles; it contracts in breadth towards the south, in Virginia, but reaches its greatest dimensions in Tennessee where it measures from fifty to sixty miles in breadth. The chain, more or less compound, which borders this great valley, towards the southeast, is more continuous and extends without any interruption from Vermont to Alabama. In Vermont it bears the name of Green mountains, which it retains to the borders of New York; in the latter State it becomes the Highlands; in Pennsylvania, the South Mountains; in Virginia the Blue Ridge; in North Carolina and Tennessee, the Iron, Smoky and Unaka mountains.

Although these features are common to the Appalachian system throughout its entire length, nevertheless, it may be divided from north to south into three divisions, which present very remarkable differences of structure. Passing the

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eye over the physical chart which accompanies this article, we at once distinguish in the longitudinal extent of the Appalachian system two principal cu. vatures, the one at the north from Gaspes to New York, the concavity of which is turned towards the southeast; the other at the centre, from the Hudson to New River in Virginia, with its concavity also towards the southeast; the third from New River to the southwest extremity of the system, the direction of which is nearly straight, or forming a gentle curve concave towards the northwest. These three divisions, diminishing in extent from the north to the south, are well marked, at the north by the deep valleys of the Mohawk and the Hudson, which break through the Appalachian system to its base and across its entire breadth; at the south by New River, whose deep valley, with vertical walls, also separates regions whose orographic charaaters present remarkable differences.

After describing the two northern divisions, he proceeds: "The southern division, from New River to the extremity of the system, is much the most remarkable for the diversity of its physical structure and its general altitude. Even the base upon which the mountains repose is considerably elevated. Although the elevation of the Atlantic plain at the eastern base of the mountains is only 100 to 300 feet in Pennsylvania, and 500 in Virginia near James river, it is 1000 to 1200 feet in the region of the sources of the Catawba. In the interior of the mountain regions the deepest valleys retain an altitude of from 2000 to 2700 feet. From the dividing line in the neighborhood of Christiansburg and at the great bend of New River the orographic and hydrographic relations undergo a considerable modification. The direction of the principal parts of the system is also somewhat changed. The main chain which borders the great valley on the east, and which more to the north, under the name of the Blue Ridge, separates it from the Atlantic plain, gradually deviates towards the southwest. A new chain detached on the east, and curving a little more to the south, takes now the name of Blue Ride. It is this lofty chain, the altitude of which, in its more elevated groups, attains gradually to 5000 and 5900 feet, which divides in its turn the waters running to the

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Atlantic from those of the Mississippi. The line of separation, of the eastern and western waters, which, to this point, follows either the central chain of the Alleghanies, or the western border of the table-land region, passes now suddenly to the eastern chain, upon the very border of the Atlantic plain. The reason is that the terrace which forms the base of the chains, and the slope of which usually determines the direction of the water-courses, attains here its greatest elevation, and descends gradually towards the northwest. The base of the interior chain which runs alongside the great valley is thus depressed to a lower level, and though the chain itself has an absolute elevation greater than that of the Blue Ridge, the rivers which descend from the summit of this last, flow to the northwest towards the great central valley, which they only reach in southern Virginia and North Carolina, by first passing across the high chain of the Unaka and Smoky mountains through gaps of 3000 to 4000 feet in depth.

The southern division thus presents from southeast to northwest three regions very distinct. The first is the high mountainous region comprised between the Blue Ridge and the great chain of the Iron, Smoky and Unaka mountains, which separates North Carolina from Tennessee. It commences at the bifurcation of the two chains in Virginia, where it forms, at first, a valley of only ten to fifteen miles in breadth, in the southern part of which flows New River; it then enlarges and extends across North Carolina and into Georgia, in length more than 180 miles, varying in breadth from twenty to fifty miles. The eastern chain, or Blue Ridge, the principal water-shed, is composed of many fragments scarcely connected into a continuous and regular chain. Its direction frequently changes and forms many large curves. Its height is equally irregular. Some groups, elevated some 5000 feet and more, are separated by long intervals of depression, in which are found gaps, whose height is 2200 to 3700 feet, but little above the height of the interior valleys themselves with which they are connected. The interior, or western chain, is much more continuos, more elevated, more regular in its direction and height, and increases very uniformly from 5000 to nearly 6700 feet.

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The area comprised between these two main chains, from the sources of the New River and the Watauga, in the vicinity of the Grandfather mountain, to the southern extremity of the system, is divided by transverse chains into many basins, at the bottom of each one of which, runs one of those mountain tributaries of the Tennessee, which, by the abundance of their waters, merit the name of the true sources of that noble river. Between the basin of the Watauga and that of the Nolechucky, rises the lofty chain of the Roan and Big Yellow mountains. The northwest branch of the Black mountain and its continuation as far as the Bald mountain, separate the basin of the Nolechucky from that of the French Broad river. Between the latter and the Big Pigeon river stretches the long chain of the Pisgah and the New Found mountains. Further to the west, the elevated chain of the Great Balsam mountains separates the basins of the Big Pigeon and the Tuckasegee; next comes the chain of the Cowee mountains, between the latter river and the Little Tennessee.

Finally, the double chain of the Nantahala and Valley River mountains separates the two great basins of the Little Tennessee and the Hiawassee. The bottom of these basins preserves in the middle, an altitude of from 2000 to 2700 feet. The height of these transverse chains is greater than that of the Blue Ridge, for they are from 5000 to 6000 feet and upwards; and the gaps that cross them are as high, and often higher, than those of the Blue Ridge. In these interior basins are also found groups, more or less isolated, like that of the Black mountain, which, with the Smoky mountains, present the most elevated points of the system.

Here then, through an extent of more than one hundred and fifty miles, the mean height of the valley from which the mountains rise is more than 2000 feet; the mountains which reach 6000 feet are counted by scores, and the loftiest peaks rise to 6700 feet, while at the north, in the group of the White mountains, the base is scarcely 1000 feet, the gaps 2000 feet, and Mount Washington, the only one which rises above 6000 feet, is still 400 feet below the height of the Black Dome of the Black mountains. Here then, in all respects, is the culminating region of the vast Appalachian system."

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The basins above described by Prof. G., are all valleys of erosion,—*i. e.*, they have been excavated by the force of the rivers which flow along their bottoms. And it is this same force which has hewn a way for these rivers out of these basins, cutting down deep channels for themselves through the lofty and massive chain of the Smoky and Unaka mountains, which form their northern boundaries. There are two remarkable points in this river and mountain system. One is, that while in the northern division of the Apalachian system, in Virginia, for instance, the rivers, rising in the more westerly chains of the system, cut through the Blue Ridge and make their way *east*. In North Carolina, on the contrary, they rise in the Blue Ridge and cut their way *west* through the Smoky. The other is, that these rise in the *smaller and lower* chain and cut through the *higher and more massive*. The probable cause of this will be considered further on.

The largest of these basins are those of the French Broad and the Hiwassee, the former having an average elevation of a little more than 2000 feet, the latter, a little less. The smallest, and at the same time, the most elevated, are those of the Pigeon and the Nolechucky, the elevation of both rising above 2500 feet.

GENERAL GEOLOGY.

The Strike (or direction of the outcrop) of the strata of this region corresponds neither to the general direction of the Blue Ridge, nor to that of the Smoky, and is subject to considerable variation. The general average will fall very near N. 50° E. In the slates of Cherokee it is less,—not far from 43°; and through the central portion of the region the average would probably be nearer 60°. A careful study of the range of the Blue Ridge through this region, will show that its principal masses, although loosely and irregularly attached to each other, manifest individually a disposition to fall into parallelism with the direction above set down as that of the average strike. This, therefore, may be considered as the direction of its controlling axis and of its constituent elements.

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The Dip. The strata, through the entire mountain region, are inclined to the horizon at a high angle, the average dip falling probably near 65°, and the prevailing direction of it being southeast. It is subject, however, like the strike, to great variation, both as to its amount and direction, being frequently vertical and northwest.

These irregularities, both of strike and dip, are greatest along the middle portion of the mountain plateau, instead of being found chiefly, as we should expect, along the limiting mountain axes; and they are quite unaffected, apparently, by the subordinate north-and-south cross-chains, except in the case of the Nantehaleh mountains, along which, particularly near the northern termination of the range, the strike is deflected much to the north, and the dip also greatly disturbed and very variable. This central area of extraordinary disturbance is also characterized by an unusual degree of contortion and folding of the strata. Within this area lies a narrow belt, its breadth varying from 5 or 6 to near 20 miles, extending from the Black mountains across the State to the southeastern corner of Clay county, in which the prevailing dip appears to be northwest. This implies the existence of both an auticlinal and synclinal axis, the former along the southern, and the latter on the northern limit of this belt. It will require further observation and a laborious investigation of details to develop these points satisfactorily.

The Rocks. The central belt above described may be considered as including the geological axis of the plateau and may be properly called its axial zone. This zone is not less peculiar in the *character* than in the *disturbed condition* of its rocks. These belong to the *granitic*, more properly the *gneissic* series, and are characterized by an extreme degree of *metamorphism*, or alteration, and are hence frequently called *metamorphic* rocks. The southern boundary of this zone passes near and to the south of Whiteside, Hogback, Tennessee Ridge and Pisgah mountains, about 10 miles east of Ashville, and strikes the Blue Ridge again a few miles north of Swannanoa gap. Its breadth is from 20 to 25 miles, its northern limit, passing just north of Marshall, Fine's creek, Cowee creek and Shooting creek. Within this area are no

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sandstones or clayslates, but an abundance of hornblendic and magnesian rocks. Hornblende slates, syenite, chlorite schists and serpentines occur in frequent and heavy beds throughout this belt, from the mouth of Shooting creek to the Yellow mountains. The chlorite schists and serpentines are generally accompanied by hornblendic rocks, and always associated with and often replaced by tremolite, soapstone, pyroxene, tale slates and actinolite rocks, and are frequently interlaminated with cellular quartz (burrstone) and contain at several points beds of chromate of iron.

True granite is found occasionally in the southern portion of this belt, rarely in the middle, and scarcely at all in the northern. Along the northern range of the belt also, the hornblendic strata are more infrequent, and the magnesian rocks almost entirely wanting, but there is an abundance of grey quartzose slates and gneiss, with pyritiferous mica schists.

These are succeeded, on the north of the axial zone, by a series of slates, argillaceous, silicious and talco-micaceous, which occupy a broad belt across the lower half of Clay county and the middle of Cherokee, and strike the Smoky mountains in the northern part of Macon. These slates are traceable along the east flank of the Smoky on Oconaluftee, across Haywood county a few miles below Fines Creek, and they appear on the French Broad 7 or 8 miles below Marshall, and continue to the State line, the silicious slates receiving here their greatest development, being in fact the dominant member of the group on the French Broad. With these slates are associated a few thin beds of fine conglomerate and grit rocks on the head waters of Valley river, which re-appear with them throughout their whole extent, becoming on French Broad and Shut In creek, a coarse conglomerate of many rods in breadth. Limestone also occurs in this series along the course of Valley and Notteley rivers.

The western part of Cherokee, from a point on Hiwasse 3 or 4 miles below Murphy, is occupied by a succession of conglomerates and grits, interbedded with mica slates and schists, and talco-micaceous slates, abounding in garnets and staurotides, and occasional beds of grey quartzose slates and gneiss,

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especially near the Long Ridge mountain. Blue and drab slates occur with the conglomerate at the State line on the Unaka mountain, and for several miles east. The conglomerates and grits of this series recur in heavy and frequent beds throughout a cross-section of near 20 miles, and are traceable across the highest peaks of the Unaka (or Unakoi) and again on the Tennessee river in the Smoky.

Along the southeast boundary of the metamorphic or axial zone, we have a narrow belt of slates, micaceous, and arena, carrying a thin bed of limestone. This limestone is traceable continuously from the Forks of Toxaway to Cane creek, disappearing in the Blue Ridge near Swannanoa gap, and cropping out again on North Fork in McDowell County.

South of the limestone belt comes another band of gneiss, grey and light colored, which is some 10 miles in breadth, and is followed by another body of hornblendic and silicious slates, with occasional mica schists and gneiss.

Drift. Although this region is far beyond the limits which geologists usually assign to glacial action, yet there are throughout these elevated plateaus numerous phenomena which have no other plausible explanation. Accumulations, many feet deep, of unstratified earth with smooth rounded stones, (mostly of quartz and other hard rocks,) are found every where through these basins, often capping high ridges and knobs one or two hundred feet above the present beds of the rivers. Such a bed is found on one of the hills overlooking the town of Asheville, near 200 feet above the French Broad. Some of the pebbles of this bed, I have traced to their origin about six miles to the south. On the slopes of the mountains along Valley river, such drift masses are common and extensive, many of the smoothed and rounded masses of quartz weighing nearly a ton.

Terraces are also occasionally discoverable, though not common. The most notable example that came within my observation is found along the French Broad, from Warm Springs to the State line, occurring at intervals for several miles, in three or four benches, ten, twenty-five, fifty and one hundred and fifty feet in height.

Age of the Rocks. The facts above stated are sufficient to

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indicate that these rocks belong to the most ancient of the azoic series. The intensity of the metamorphison, the characteristic rocks and their contained minerals, together with the total absence of any thing like organisms in even the least altered and latest of the series (in Cherokee for example) render this conclusion inevitable. And not only do they belong to the lowest geological horizon, but the entire absence of all representatives of the later formations makes it further necessary to conclude that we have here an extensive tract of the oldest land on the globe; and as North America is the eldest-born of the continents, so the Black mountain is the eldest of its giant brotherhood, and was the first to emerge from the face of the unbroken sphere of waters, when the command went forth "Let the *dry land* appear."

The facts above given, also point to the explanation of the remarkable relation of the river system of this section to its mountains, viz., that they rise along the smaller, and break through the greater range. This explanation is probably to be found in the relative age of the two chains, as ascertained from that of their component rocks, the Blue Ridge being the more ancient, and having determined the courses and channels of the rivers before the rise of the Smoky.

ECONOMICAL GEOLOGY.

The mountain section of North Carolina, has not been hitherto known to the world as a mineral region. And yet it contains several well marked mineral tracts whose riches are not surpassed in any other part of the State or country. Such are the limestone belt of Cherokee, with its marble, iron and gold; the copper belt of Jackson, and the iron beds of the Yellow mountains. It will, perhaps, be more intelligible to consider separately, the several minerals which occur in valuable accumulations in this section. And first,

LIMESTONE.

The value of this mineral is not yet appreciated by our farmers. Its importance in an agricultural point of view

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it would be difficult to overstate. Dr. Hitchcock, in his report of the Geological Survey of Vermont, says of a discovery which he made of a limestone bed in that State, "This is a treasure which Providence has hidden in the earth and provided for its elimination at the right time and in the right quantity, and it is of far more value, in my estimate, than all the other subterranean wealth of the State." I am not sure that this should be regarded as an extravagant statement, if applied to this State, rich as it is in other minerals. I have, therefore made it a point to search for this rock, wherever there was the least prospect of its discovery. The most extensive and valuable l mestone belt in this region is that of Cherokee. As already stated, it is found in a heavy body of slates, and consists of three or four distinct beds, separated by slates, and occupying a variable breadth of two to five miles. It extends from the Ocoee river into and across Cherokee, lying along the valleys of Notteley and Valley rivers, quite to the sources of the latter, and re-appearing on the Nantahaleh river in Macon connty. It crops out along the banks and beds of the streams, in the fields and roads and the bluffs overhanging the rivers, so as to be easily accessible and convenient for agricultural purposes.

There are three other beds of limestone in the mountain region, all of them crossing the French Broad. The most important of these, both on account of its extent and its location, is the Cane creek and the Toxaway bed, which passes near the mouth of Muddy creek. Lime is extensively manufactured along the line of this formation, many thousand bushels being distributed annually from one kiln, over the neighboring farms, the value of which has, by this means, in many cases, been already more than doubled. A second belt crosses the river near the mouth of Bear Creek, about two miles below Marshall. This is a crystalline rock, a true marble, but rendered unfit for ornamental purposes, at the few points where I saw it, by the presence of crystals of a magnesian mineral. This is a thin bed, only a few rods in breadth and lies along Walnut and Bear creeks; with a subdivision, probably crossing the river at the town of Marshall. The third belt is found in heavy outcrop at and below Warm

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Springs. This is a compact, blue and gray limestone, scarcely crystalline.

MARBLE.

I have no statistics at hand to show the quantity of this material, which is annually imported into this State from the quarries of Massachusetts and Vermont, and the amount of money which passes beyond our borders in payment; but any one who has occasion to observe the amount of business which is done in our marble yards, and still more who will consult the census returns to see how many scores of vessels and how many thousands of laborers are employed in the two States above mentioned, to furnish us and our neighbors with ornaments for our homes and monuments for our dead, will be surprised at the magnitude of both these items. If this were inevitable, there would be no profit, or propriety in speaking of it here. But the fact is far otherwise: for we have within our own borders an abundance of marble, equal to the best imported article. The limestone of Valley river is all marble, although it is not everywhere sufficiently free from flaws and impurities for ornamental uses. There are several quarries, however, where the rocks crop out in masses of fine quality and grain. The track of the proposed rail road lies along the line of these quarries, and will be built, for many miles, upon beds of solid marble. It is of several shades of color, generally white and blue to bluish-grey. I have seen specimens also of a fine mottled (blue and white) variety, from the head of Valley river. But the finest grained and tinted specimens are found on Red Marble creek and Nantehaleh river. The most beautiful shades are grey, and rose, to flesh colored. I have seen no marbles from any part of the world superior to these.

IRON

Is found, in some of its various forms of ore, in most of the western counties, but its most important localities are Cherokee and Mitchell. These are worthy to be mentioned with the Iron mountain of Missouri. The iron ore of Cherokee belongs

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to the class known as hematite. It occurs along with each of the parallel subdivisions of the limestone, sometimes on both sides of them. It outcrops in immense masses along Notteley, on Hiawassee at the junction of Valley river, on Peachtree creek, and the whole length of Valley river, an aggregate distance of twenty-five miles. One of these beds, which appears on Peachtree, is a soft, uncompacted brown ochre, which has been mined for paint. This bed is well developed in the upper portion of the valley of Valley river, on Paint creek, and again above Valleytown. The ores from many of these beds have been wrought in the common bloomeries of the country, (of which there were, perhaps, half-a-dozen in the county,) and even under this mode of treatment, are said to yield a large per centage of metal of good quality. And those beds of slaty ore, which are not workable in such open forges, would be easily smelted in a blast furnace.

It is apparent, therefore, that there exist in Cherokee county, the most favorable conditions for the manufacture of iron on an indefinite scale. Three large rivers flow along and over the edges of these *iron mountains*, furnishing unlimited power, and at all points; the ore is interstratified with limestone for fluxing; and the neighboring mountain slopes abound with fuel. And if this were not sufficient, the distance is only twenty-five miles to the State line, where a rail road will shortly bring mineral fuel from Chattanooga. Nothing is wanting but transportation, to develop here a manufacturing interest equal to any on the continent.

The other principal iron bed is that of Mitchell county, near the head of Toe river. This ore is found in the gneissic series of rocks, and is magnetic, or *grey* ore. It occurs in an immense bed of hornblende slate and synite, near the base of the Yellow mountains and a few miles from the State line. The outcrop is on the lower slope of the mountain, perhaps 200 feet above its base, and reveals a network of heavy "veins," or beds, extending over several acres of surface. It is inexhaustible in quantity. The iron manufactured in the bloomeries of the neighborhood has been long celebrated for its tenacity and durability, and is admirably adapted to the manufacture of steel. It is known as the Cranberry iron, from a

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small stream near the ore banks. Here, also, exist the best natural facilities for the manufacture of iron. Water-power and fuel in the greatest profusion are at hand, and the only difficulty here too, is in the matter of transportation, which, however, could be readily overcome.

Magnetic ore is found in many other localities, and no doubt this Cranberry ore will be discovered in other outcrops in these mountains. Ore of the same character, appears at the western base of the mountain, at Flat Rock, which is probably a continuation of the same series of beds. Magnetic ore occurs near Marshall also, in Madison county, and again near Fines creek, in Haywood; in each case, having the same association of hornblendic rocks. It is also found in Macon county at several points, here in a garnetiferous mica schist. Hematite ore occurs at one or two points in Buncombe, and a bed of it also overlies the limestone in Transylvania county, appearing again with it on the North Fork in McDowell. This association with limestone, which occurs so frequently, is not accidental, but points to the origin of these ores.

GOLD.

There are two principal "gold regions" in the mountain section, one in Cherokee, the other in Jackson. The gold belt of Cherokee is in the same body of slates which carries the limestone and iron. It is found both in veins and superficial deposits. The sands of Valley river yield profitably through a large part of its course, and some very rich "washings" have been found along its tributary streams on the north side. The origin of this gold is very near the limestone. A remarkably rich vein has been opened near the town of Murphy, known as No. 6, which immediately underlies the marble. This is a silver-lead quartz vein, in which is embedded a large per centage of free gold. There is a strong probability of other similar veins having furnished the golden sands of the river and streams above mentioned.

On the southeast of the limestones is also a series of "diggings" along the lower slopes of the mountains, from near Valleytown to Vengeance creek, a distance of 12 or 15 miles.

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The gold is found here in the drift which covers the lower spurs and terminal ridges of the mountains lying south of Valley river. The drift-beds have a depth of 10 to 20 feet and an elevation above the river of 150 to 200 feet, and are remarkable for the great size of their quartz boulders and their very large and abundant stanrotide crystals. These last indicate, with a good degree of probability, that the gold here is derived from the talco-micaceous slates, (several miles to the southeast) where these crystals are found in place.

At one point, the Parker mine, extensive arrangements had been completed at the opening of the war for working these deposits by the hydraulic, or hose process. For this purpose water was conveyed three or four miles along the face of the mountain in canals and aqueducts so as to gain the necessary elevation.

The continuation of this gold belt southwestward across the country, is rendered probable by the existence of several valuable mines in this direction beyond the Hiwassee, as the Warren mine on Brasstown creek and others on Nottleley river, in the edge of Georgia. These being vein mines, may, on a proper investigation, lead to the discovery of the original source of the deposits above described.

The gold of Jackson county is also obtained almost entirely from "washings," These are situated chiefly along southern slopes of the Blue Ridge, near Hogback and Chimney Top mountains. The most important locality is Fairfield Valley, where Georgetown creek, one of the head steams of the Toxaway, is said to have yielded between two and three hundred thousand dollars. The deposits extend several miles along these elevated basins and have by no means been exhausted. The origin of the gold here is doubtless to be sought in veins in the Blue Ridge, which rises as a precipitous wall of grey gneiss, sheer up from the valley 7 or 800 feet, on the north and east; and it is along the base of this wall, where Georgetown creek has cut a deep channel across it. that the gold is principally obtained. The deposits in Transylvania county east of the Blue Ridge, on the head waters of French Broad, will probably be found to have the same origin, and are probably a continuation of the same belt.

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COPPER.

I am not aware of the existence of copper in the mountain section, except in what I have called the Jackson belt, because it is in this county that the formation receives its principal development, although it crosses the whole breadth of the State, and has yielded copper at several points in Macon, on the one side, and Haywood on the other.

The general character of the formation has already been given. The feature, which it is most important to recall, as worthy of special attention, is the existence of numerous beds of syenite and hornblende slate throughout the tract. The relation of these to the magnetic iron ore has already been pointed out. They also carry the copper. All the copper mines I have seen in this region show this peculiarity. These deposits seem, in fact, not to be the true *veins* in the technical sense, (although they are in the popular) but *impregnations* of ore, of the same class with those of the Ducktown mines; but belonging to an entirely distinct age and system of rocks. The copper belt occupies the whole middle portion of Jackson county, from the head waters of Tuckasegee river, northward to Scott's and Savannah creeks, and probably several miles beyond. None of the deposits have been properly opened and exposed, so as to afford an opportunity for a full and satisfactory examination; but so far as this has been done, many of them are of the most promising character, and the "veins" are of unusual size. The principal points where mining operations have been carried on are Cullowhee, Waryhut and Savannah, although work has been done and symptoms of the presence of copper discovered at many other places, as Shell Ridge, Scott's creek, Sugarloaf, Panther Knob, Wolf creek, &c.

The ore at Cullowhee, where the best exposure has been made, (although only the surface of it has been touched even here) is eight or nine feet thick; at Waryhut, five or six feet; at Savannah, where there are several "veins," or beds of ore, the largest which has been opened is nine or ten feet. In several of the above localities copper was found within a few

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feet of the surface. The outcrop in all cases is the mineral known among miners as "gossan," really an ore of iron, (limouite or hematite) and has resulted from the *weathering* and decomposition of the exposed ore, which is "yellow copper," or copper pyrites, from which the copper and sulphur have been removed to a considerable depth by the chemical action of the atmosphere.

"Gossan" occurs at many points throughout the Jackson county belt, the beds running with the strata, northeast and southwest, in some cases a single bed being traceable, interruptedly, almost across the breadth of the county. Such an outcrop is visible on Chink Knob near Tennessee Ridge, associated with a heavy bed of hornblende slate, and also accompanied by a garnetiferous mica slate.

These copper deposits will, no doubt, under a judicious system of mining, (*not speculation*) give rise to many valuable mines. This will require capital, however, which of course will be slow to seek investments here, until means of transportation to market shall have been provided.

Here is undoubtedly one of the most interesting mineral regions of the State, both scientifically and economically, and it merits a thorough exploration; which of couse I could not give it in the two weeks devoted to this county.

In the above brief sketch of a few of the more important minerals and mineral localities of this region, of course many points have been omitted which are of great interest to the Geologist and Mineralogist, because time does not allow me to introduce them here. In fact this description is too hurried to do justice even to the practical aspects of the subject; and many points which my rapid survey did not permit me to examine at all, have been reserved for future investigation.

AGRICULTURE.

A few observations of a general character is all that can be attempted here.

Climate. The latitude of the middle of the mountain plateau is about 35½°, and the average elevation over 2000 feet; and since 500 feet of difference of elevation are about

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equal, in climatic effect, in the temperate zone, to 1° of difference of latitude, the climate will be found to correspond to that of northern Virginia and southern Pennsylvania.

Soil. From the description already given of the rocks, the general character of the soil may be readily inferred. A peculiarity which strikes all strangers on first visiting this section is that the mountains are clothed, quite to their tops, with the heaviest forest growth. And where this is not so, those which are bare of trees, are covered with a crop of indigenous grasses. It is seldom that bare rocky summits are seen, as is so frequently the case further north, in the White mountains for instance. These facts indicate at once the presence of a substantial soil, even at the greatest elevations. Its average quality for the whole section is quite equal to that of the middle region of the State; and the alluvial soils along many of the rivers will compare favorably with the best lands in the country.

Timber is found every where in the greatest variety and abundance. In addition to the oaks and other species which grow further east, there are here, in many localities, forests of sugar maple, walnut, wild cherry, white pine and black locust, and other timbers which will one day become an important source of business and profit.

Products.—Corn, oats, rye and the common potato flourish throughout this region, and constitute the staple products.—Wheat does well in several counties, particularly in Madison and Haywood. The grasses, especially timothy, herd, orchard, blue, and clover, grow luxuriantly. The highest mountain summits, ridges and plateaus are natural meadows; good summer range is abundant everywhere, and there are large tracts on the higher table lands, where are two or three species of grasses which remain green through the winter.—Hence cattle and sheep-raising are among the most profitable occupations.

There is probably no better region for fruit in the United States. Apples grow almost spontaneously, and there are many seedling varieties which have originated here, that are equal to the most celebrated exotics. And I have seen apples of good quality growing wild on the tops of mountains

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nearly five thousand feet high, where the seed had probably been accidentally dropped by the hunter.

Tobacco also, flourishes remarkably in this region. Indeed I do not remember having seen it grow better anywhere than in Cherokee, for example. And from the abundance of feldspar in the rocks, and hence of alkali in the soil, (as is also evidenced by the remarkable prevalence of hickory growth,) of the southern half of Jackson county, this section also will no doubt, be found to be specially adapted to this crop. Here is then the suggestion of a new industry which might become an important resource to the inhabitants.

Probably more than $100,000 are annually put into circulation in the mountain region, in payment for indigenous medicinal roots which are gathered chiefly in the rich coves and on the highest ridges. Among these are ginseng, snakeroot of several species, and pinkroot. The first named is the most important, and has long been the basis of a considerable trade. I was not able to get a reason for the neglect to cultivate this valuable plant, and could not learn that the experiment had ever been tried. The high price which it bears and the large and constant demand abroad would certainly justify such an effort to improve so obvious a hint of nature.

CHAPTER III.

A BRIEF SUMMARY ON THE MINERALS OF NORTH CAROLINA.

The result of the different surveys and explorations which have been made up to this time, are scattered, as we have seen, through a series of reports and documents by different authors; and at times considerably distant; some of them are out of print and all of them scarce, so that possibly not half a dozen individuals—perhaps hardly two libraries in the State possess them all.

A brief resume, or condensed statement seems therefore to be required, of at least those results which have an immedi-

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ate practical bearing upon the development of our mineral resources. For want of time to prepare a fuller and more comprehensive account of the whole survey, the following very concise summary on "The Minerals of North Carolina" is given. It is substantially the same paper which I prepared for publication a short time before undertaking the present survey. The substance of it, therefore, with the exception of some points relating to the extreme western portion of the State, with which I became acquainted in the course of my exploration during the past season, has already been given to the public in another form.

A statement of some general principles, and a few observations on the leading geological features of the country, will make the subject more intelligible. The position, general arrangement and condition of the rocks of a region have always an intimate dependence on its mountain systems. The strike, or direction of out-crop of the strata, may generally be predicted as soon as the direction of the dominant mountain range is ascertained. Thus the different beds of rocks on the eastern side of our continent fall into parallelism with the axis of upheaval of the Apalachian system. The general direction of the Blue Ridge, therefore, gives us approximately the geological meridian to which all the rocks of North Carolina must be referred. This direction s nearly north-east and south-west. Every one has noticed that the edges of the outcropping strata, and in general the trap dykes and mineral veins, take this direction predominantly in our latitude. The beds of slate, limestone, gneiss, &c., follow each other in regular succession, all trending away to the north-east. So that in passing from the sea coast to the mountains, we cross successively in our track the upturned edges of the whole series. Thus we have the clue to the distribution and arrangement of the rocks in mass.

In the study of the metalliferous minerals, it is important to bear in mind two leading facts: first, that they are found, especially the precious metals, chiefly on the flanks of mountains and in tracts marked by disturbance and upheaval, in the vicinity of trap dykes and other eruptive rocks, and at the intersections of these with slates; and second, that their oc-

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currence is most frequent in the oldest formations, the Primary and lower Secondary.

The rocks of North Carolina belong to this lowest horizon, being wholly included, with the unimportant exception of the coalfields, in the Primary group. So that we are prepared for the statement that there is hardly to be found a territory of the same extent, with so great a variety of valuable minerals. In the treatment of this subject, it will be sufficiently precise for our purpose to divide the useful minerals into two classes, namely, the metalliferous ores, which occur mostly in veins, as gold, copper, &c., and earthy minerals and rocks, which are found mostly in beds, as coal, limestone, &c.

Under the first division, occur gold, silver, copper, lead, zinc, iron and tungsten, and here, for convenience, may be added the diamond; and under the second, may be mentioned, as occurring in this State under such circumstances, as render them economically valuable, coal, marl, limestone, marble, architectural granite, sandstone, porphyry, fire-stone, burstone, grindstone grit, whetstone slate, roofing-slate, alum and copperas slates, soapstone, serpentine, agalmatolite, fire-clay, graphite, garnet, barytes, manganese, oil slates, and chromate of iron.

COAL.

The second division, being most important, will first claim attention; and first among these coal.

The value of this mineral is too well known to require statement even. The development of all arts and industries is connected with its abundance and cheapness. It is found in two districts in North Carolina, known as the Deep River and Dan River coalfields. In both, the coal is bituminous, and occupies a narrow tract of country along the course of the rivers from which they respectively take their names.

These beds, therefore, follow in their outcrop the general direction of the rocks of the country. The Dan River bed is distant from market, and has been little explored. There is an outcrop in Rockingham and Stokes counties, one seam being four feet thick. The Deep River bed is better known,

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and probably more extensive. It is described in detail, in the Geological Reports of Dr. Emmons, for 1852 and 1856, and also by Admiral Wilkes, in his report to the Secretary of the Navy, in 1859. According to these authorities, this coal is of the best quality, well adapted to the manufacture of iron and gas, and is inexhaustible in quantity. They represent it as extending over an area of more than forty square miles, and containing more than 6,000,000 of tons to each square mile. This bed, therefore, would yield 1,000,000 tons annually, for several hundred years.

OIL.

These North Carolina coalfields are cotemporaneous with those of Virginia, and belong to an age more recent than the Apalachian coal formation, which ranges from Pennsylvania to Alabama. They belong to the later ages of the Secondary.

The bituminous slates associated with the coal are strongly impregnated with organic products. Dr. Emmons says, "From thirty to forty gallons of crude Kerosene oil exist in every ton of these slates. They are from fifty to seventy feet thick, and it is proper to state, that it is a better oil than is furnished from coal." The coal lies in a trough-like depression, which extends from Granville county, in a south-west direction, into South Carolina. This tract is occupied, in its whole length, by a heavy bed of sand stones, of the same age with the coal. They are identical in appearance, quality and age, with the brown-stone of Connecticut valley, which is so extensively used as a building stone in New York and elsewhere. These sand stones are also extensively quarried for grindstones, for which they are well adapted.

FIRE-CLAY, &C.

Beds of fire-clay, also, are interstratified with the coal.—This mineral is found in various parts of the State, conspicuously in Gaston county. There are five or six parallel belts of sandstone and quartzite, belonging to the older rocks, which traverse the State in the prevailing direction, and in

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which are found various grades of building-stones, fire-stones and grindstones. According to Dr. Emmons, one of these passes eastward of Raleigh, another a few miles to the westward, and a third crosses the counties of Montgomery, Randolph and Orange. The well-known fire-stones of Gaston Lincoln and Catawba, occur in the fourth belt, which crops out along the line of upheaval of King's mountain, Crowder's mountain and Little mountain. This rock in places assumes the character of white granular quartz, (saccharoidal quartz of the mineralogist) and attain sufficient purity to be used in the manufacture of glass. Linville mountain, in McDowell county, at the eastern base of the Blue Ridge, is chiefly made up of the same rock. Here is found the flexible sandstone (Itacolumite of the mineralogist) in which the diamond occurs in other parts of the world.

LIMESTONE.

In addition to the four beds of this rock in the western counties, there are two beds east of the Blue Ridge; one is in McDowell county, along the North Fork, the other crosses the State from King's mountain, along through Gaston, Lincoln and Catawba to Stokes. There is also a small bed of marly limestone eight or ten miles in length in the northwestern part of Wake county.

PORCELAIN CLAY, &C.

Agalmatolite constitutes another member of the sandstone group in at least two of the zones, being found in this connection in Montgomery and Chatham, as well as on the Nantehaleh river, and across Cherokee county. This rock is miscalled soapstone, which it resembles in some of its properties and uses.

It is developed here on a large scale, and in no part of the world is found in greater purity or extent. Its uses in the arts are manifold, being substitnted for graphite in lubrication, and for soap-stone in furnaces, prepared as a cosmetic and a pigment, and manufactured into soap, into ornaments,

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and the finer kinds of porcelain ware. It has been exported for this latter purpose in large quantities to New York, and to Germany.

GRAPHITE.

Here, also, belong the famous graphite, or plumbago beds of Wake county, being found immediately under the sand stone, or quartzite. It occurs, likewise, in the same connection, in the Catawba belt, and scattered through several counties westward. The uses of this mineral are well known and important, the principal of which are, for the so-called lead pencils, for crucibles, for paints, for lubrication and for electrotyping, &c. The Wake county mines have been worked to a considerable extent, and will, no doubt, be re-opened. Dr. Emmons and Prof. Olmsted pronounce these the most important beds of this mineral known.

The quartz rock of this group in Montgomery, takes the form of a buhrstone, which is supposed to be valuable for the manufacture of millstones. This mineral is also found near Webster, in Jackson county, and on Nantehaleh river, in Macon.

SOAPSTONE, WHETSTONES, &C.

Soapstone and serpentine of good quality are found in various parts of the State, for example, in Wake, Moore, Orange Randolph, Mecklenburg and Caldwell, and west of the Blue Ridge, there is a remarkable dyke of serpentine and chlorite slates, traversing the State from Clay to Mitchell, which carries a great variety of minerals, interesting to the mineralogist, and one at least that might become valuable economically.

Here is one of the few veins of chromate of iron found in the United States. This mineral yields a larger number of valuable paints than any other substance known. The slate formation, which occupies a tract of the State, not less than forty miles in width, lies west of the coal rocks of Deep river, and extends in a north-east direction, from Anson and Union counties on the southern border, to the Virginia line. These

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slates constitute a notable feature in the geology of the State, and, in addition to the interest which attaches to the numerous mines along its north-western border, they contain extensive beds of roofing-slates, whet-stones and turkey hones, (novaculite.) Scythe-stones are also found on the Nantehaleh, of good quality and in great abundance.

ALUM AND COPPERAS.

Alum and copperas slates abound in many parts of the State, and have been extensively brought into requisition during the stress of the late war. The counties of Cleaveland and Rutherford alone contain not less than 100 square miles of these rocks, and could easily supply the continent with copperas. This material is derived by the process of weathering, from the iron pyrites which is disseminated in great abundance, and in a state of extreme comminution through the slates, many of which, being feldspathic, yield also alum.

MINERAL SPRINGS.

The pyritous character of these rocks accounts also for the numerous mineral springs, sulphur and chalybeate, for which this region is noted. Among these, Wilson's springs are the best known. They belong both to the white and red sulphur waters, as they are called, and have no superior in Virginia or elsewhere. Mineral waters are not limited to this region, however. No section of the State is destitute of them, and in the mountains they are found every where.

BARYTES

Is found in Orange, in the mines of Cabarrus and Mecklenburg, also in Gaston and Madison counties; and manganese in Cabarrus and Gaston as well as in Lincoln, Catawba and elsewhere.

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MARL.

This valuable mineral is liberally scattered over most of the seacoast section of the State, and is found in every degree of purity and consolidation, from a mere aggregation of loose shells to the most compact limestone, suitable for building, or for burning into lime. The famous Bath stone of London is matched by some of these beds. The marl is generally found near the surface and easily accessible. The importance of these accumulations of mineral manure to the agriculture of the State is not fully appreciated. Our farmers are only beginning to understand the essential part which lime plays in the economy of vegetable growth, and its important relations to exhausted soils.

We pass to the other division of minerals, the metalliferous ores.

To the unpracticed eye, nothing presents a picture of more hopeless disorder and chaos than the rocks, particularly in a region of great disturbance, as in a mountainous country. Here seems truly "A land of darkness, without any order, and where the light is as darkness." And yet, at the touch of science, order rises out of this confusion, and light spreads over this darkness. In a region of the wildest riot of disorder, dislocation, disturbance, and inversion, under the patient and inevitable inductions of geology, the upheaved, overturned, and distorted strata fall into rank and regularity along certain axes and group themselves orderly about certain centres. As the sandstones, limestone, &c., of the previous division were found to acknowledge certain relationships *inter se*, and toward a controlling geological meridian, so it will appear that the metalliferous ores are not scattered at random and as if by chance, (even within the limitations already stated, of a disturbed area and a low geological horizon) but have a subordinate grouping and a palpable arangement.

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IRON.

And first of iron, king of metals; so, because it constitutes the very frame-work, as it were, of our material civilization, without which the whole fabric would vanish like the fabled ship on approaching the magnetic mountain. North Carolina is peculiarly fortunate in the possession of an abundance of iron ore, and so widely distributed and in so immediate juxtaposition with the other materials and means for smelting it, that each section, except the sea-board counties, can produce its own supply. These ores occupy chiefly five or six narrow tracts, or districts, which have an obvious relation to the mineral belts already pointed out.

This relation is most obvious and most immediate in the trans-Catawba tract, the ore being found in heavy veins along the outcrop of the sandstone from King's mountain through Gaston, Lincoln and Catawba, to Stokes and Surry. A second belt extends through Montgomery, Randolph and Guilford. A third has its largest development in Chatham in the neighborhood of the coal, but makes its appearance also in Johnson and Orange.

In the coal-beds themselves, according to the high authorities already cited, exists an important deposit of iron ore interstratified with the coal. West of the Blue Ridge, and not far from the sandstone belt, is one of the most valuable accumulations of iron ore to be found in the country. It has been long famous for the fine quality of the metal which it yields. The ore lies at the base of the Yellow mountain in Mitchell county, and is found at several points in a south-west direction in Madison and Haywood.

Another bed accompanies the limestone of McDowell and Transylvania, and one of the most important and extensive deposits in the country, crosses the entire breadth of Cherokee. It will doubtless be found elsewhere in the further investigation of the minerals of this almost unexplored mountain region. The ore is found at several points outside of these well marked districts. It belongs commonly to the variety known as magnetic. To this, however, there are many exceptions. Specular or hematite ore often replaces it, or is asso-

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ciated with it. The ore at several of the points mentioned is well adapted to the manufacture of steel.

The manufacture of iron had attained to considerable importance in the State previously to the late war, during which, of course, this industry received a great impetus. And when our system of Internal Improvements shall have been completed, this will doubtless become one of the most important manufactures in the State.

GOLD.

Gold mining commenced in North Carolina about fifty years ago. The first impulse was given to the business by the accidental discovery of some large nuggets in Cabarrus and Anson counties. Previously to the year 1820, not more than $50,000 had been obtained. In 1863, the aggregate yield was not less than $10,000,900; which would make an average annual yield of $250,000. The larger part of this was obtained from a small area comprising about half a dozen counties, lying chiefly along the Peedee and lower Catawba, but extending north-east from Mecklenburg and Anson to Guilford. Here, as elsewhere, the first mining was confined to "surface-diggings." And in 1824, Professor Olmsted, of the University, then State Geologist, expressed doubts about the existence of gold veins in that region.

In California, Australia, along the Andes and the Ural,—everywhere, in ancient and modern times, these superficial deposits have been the chief source of the precious metal, and have been generally more remunerative than vein-mines. And it is in this detritus of sand, gravel and clay, that nearly all the large masses, or nuggets, of gold have been found. They seldom occur in veins, although these detrital accumulations are doubtless the debris of denuded veins. In North Carolina, however, vein-mining soon obtained great prominence; and the larger part of the whole product in this State has been derived from this source. Some single mines in the gold region have yielded from one to two millions. And if these mines have not been uniformly profitable, it is because they have been generally wrought with little science, or

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economy. *Overman, in his work on Mettallurgy, has recorded his conviction that these mines, under proper management, would be more profitable than those of California.*

Although the mines are more numerous and important in the region indicated, yet they are by no means restricted to so narrow a district. Many valuable mines occur far outside of this "gold region," as in Moore and Franklin, on the east, and in Gaston, Catawba, Burke, Jackson and Cherokee.

The vein-gold of this State is usually found in a gangue of quartz, or disseminated in a slaty veinstone; and is commonly associated with iron and copper pyrites. This association almost universally prevails below the water-level. These mines, therefore, are of the same character as those of California and Colorado, and the new methods which have been devised during the last few years, to meet the difficulties of working this class of ores will doubtless be found applicable here.

SILVER.

It will be observed that the richest gold mines lie along and near the line of contact of the slates and granite. And it is also along this line that the principal silver mines of this State are found. The most noted of these is at Silver Hill, in Davidson county. The combination of metals here is quite complex,—including, with the silver, gold, lead, copper and zinc. A chain of similar mines runs south-west along the western border of the slates, including the McMakin and Stewart mines. During the war, the first named of these mines yielded a considerable quantity of lead. It had been previously worked chiefly for silver and gold. The same association of metals occurs in Cherokee.

LEAD AND ZINC.

Lead has not been found in quantities to justify operation elsewhere in the State, although its existence has been ascertained in several localities in the mountain region, as in Mc. Dowell and Cherokee. Both the silver and lead of North

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Carolina are found, mostly in combination with sulphur in galena.

Zinc is not known to occur in the State, except in the above named association and localities.

COPPER.

Copper has been long known as an accompaniment of gold in most of the mines of that metal, especially in those which occur within the belt of granite bordering the slates on the west. Many of these, which were originally operated as gold mines, were abandoned on account of the increase of copper pyrites with the depth; and it is only within a few years that several of them have been reopened as copper mines. A considerable quantity of this ore has been exported, chiefly from the mines of Guilford. And as it is a well-established fact that copper veins improve downward, and as these veins abound in the gold region, and have recently been found also of a very promising character in Ashe county, and are known to extend in a well-marked belt of copper-bearing rocks through several of the western counties, and many promising mines have been recently opened in Jackson county, there is every probability that copper-mining will be developed into an important interest. The mountain region has been little explored, the geological survey having scarcely been carried beyond the Catawba, but it is undoubtedly one of the richest mineral sections of the State, as it is also one of the most interesting and attractive on account of its great agricultural capabilites, the salubrity of its climate, and the grandeur and variety of its scenery, containing as it does, the most elevated table-lands, and loftiest mountain ranges to be found in the Atlantic States.

TUNGSTEN.

Tungsten, a metal which was long merely a chemical curiosity, but has recently aseumed a high value, particularly on account of its relation to the manufacture of steel, occurs in Cabarrus.

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DIAMONDS.

Several valuable diamonds have been found in the trans-Catawba, country, in Lincoln and Rutherford counties.

From this very rapid survey of the minerals of North Carolina, several facts worthy of note are evident: first, that, though widely distributed, they are not scattered at random, but follow a certain order of grouping and association; so that the probability of the occurrence of a given mineral in any particular locality can be approximately ascertained before examination.

Again, it is evident that this State is abundantly supplied with the more important and valuable minerals, those which are essential to the permanent and successful development of our agriculture and manufactures. Among these must be always first named iron, coal and lime. Of the first two it has been seen that there is the greatest profusion. Of lime, however, it may be supposed that there is a deficiency. It is true that we have no such immense territory of limestone as is found in some of the other States; and yet, upon consideration, it will be apparent that nature has provided an abundant store for all possible needs. The tertiary region in the east finds an ample supply for the purposes of agriculture and architecture in its widely diffused beds of marl. And although the farmer of the middle and western sections may not always find an imperative need of this fertilizer, his soils being frequently derived by disintegration from rocks which contain a considerable per centage of lime, yet, since the breadth of the State is traversed at comparatively short intervals by a number of outcrops of limestone, which are crossed almost at right angles by our rivers and many of our rail roads, it is thus brought within convenient reach of almost every neighborhood. Nature has denied us only two of the more important mineral deposits, salt and gypsum, (and they may yet be discovered in the sandstone of the coal.) But of these two there is an unlimited store just across our borders, within easy reach by a short line of rail road, of our network of proposed and completed rail roads and of our rivers. Taking, then, in one view, our resources of iron, coal, and

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lime, of gold and copper, and the great variety of other minerals of subordinate but real and increasing value, it is sufficiently apparent that our State has here the foundation of indefinite wealth and prosperity; and that there is wanting to these ends only a vigorous prosecution of our system of internal improvements on the part of our Legislature, and intelligence, industry and enterprise on that of our citizens.

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